

Results of U. S. Moorings Sediment Study
June 14, 1994

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Introduction

1. This report is a summary of results of physical and chemical testing of surface sediment samples, collected on June 14, 1994, at the U. S. Moorings located on the west bank of the Willamette River at River Mile (RM) 6.2. Surface (approx. 0-5 inches) sediment samples were collected to determine whether there exists any serious contamination in the area where piles will be driven for a proposed small boat moorage. In addition, samples were collected over a representative area of the water portion of the project to create an environmental "image" of the Plant Project waterside. A total of 21 stations were sampled. With compositing, 15 sets of analyses were conducted for TOC, TBT, AVS, metals, PAHs, phenols, phthalates, and pesticides/PCBs. Dioxin/furan analyses were conducted on 4 samples. These results will be compared to the results of earlier testing of sediment samples collected upstream in 1988 and near Dock A in 1989.

2. Before describing the 1994 results a little background will be presented reviewing previous physical and chemical data from sediment samples taken in 1988 and 1989. In October 1989 three vibracore samples were collected along Dock A (Figure 1), these were tested for contaminants in anticipation of deepening the berthing area for the dredge Essayons. The three samples greatly exceeded established concern levels for the heavy metals lead (Pb), mercury (Hg), and zinc (Zn), several pesticides, and PAHs (1,2,3). Dock A has not been dredged as a result of the 1989 evaluation. Additional evaluation of the material to be dredged and the management options for the material dredged needs to be addressed prior to any dredging activities.

3. The probable sources of contaminants are speculated to be from upstream. Upstream from the Moorings are located two Superfund Sites, Doan Lake on the same side of the river and McCormick & Baxter on the opposite side. Adjacent and upstream of the Moorings is the NW Natural Gas site (previously A.K.A. the Portland Gas and Coke Company), an abandoned oil gasification plant, that has soil contaminated with waste products. In 1988 USACE collected 16 samples between RM 2.1 nad RM 11.7. Most of the samples were taken along the edges of the navigation channel in the proximity of outfalls and ship moorings. Many of the sediments showed elevated concentrations of the heavy metals cadmium (Cd), copper (Cu), mercury (Hg), lead (Pb), and zinc (Zn). There was a high level of DDD and DDT in one sample just upstream from the Moorings at RM 7.3. The Doan Lake outlet (RM 7.1) appears to be an area of large DDT concentrations (4).

4. Plans have been developed for improving the Moorings facility west of Dock A towards the shoreline. This involved two alternative small boat mooring docks. One alternative was to deepen the area near the shoreline and install pilings and new dock structures. This alternative would require dredging. The second alternative called for constructing small boat moorage facilities in deeper water where dredging was not necessary. Seven sediment sampling stations were located in the area of the second deeper alternative.

5. In view of the 1989 Dock A results and because of the contaminated sites upstream, there was reason to believe that the whole area of the Moorings might be contaminated. Accordingly, surface sediment from the area was sampled over a wide area to determine the extent and character of chemical contamination. Twenty-one surface grab samples were taken by ponar on June 14, 1994 at the locations shown in Figure 2. All 21 samples were subjected to physical analyses that involved grain size distribution and standard dredge tests - void ratio, volatile solids content, resuspended density and specific gravity. Fifteen (15) samples were subjected to tests for chemical contaminants. Nine (9) of these were individual samples and 6 were composites. The locations of composited samples are shown in Figure 2. All 15 samples were tested for metals, PAHs, pesticides, PCBs, phenols, phthalates, TBT, AVS and TOC. Four of the samples were also tested for dioxins and furans. All sampling, handling, storage and analyses were conducted according to standard methods approved by the EPA and USACE jointly (2). The physical tests were performed by the Corps of Engineers, North Pacific Division Laboratory, Troutdale, Oregon. Chemical tests were conducted by Columbia Analytical Associates, Kelso, Washington, except for dioxins, which were analyzed by Alta Analytical Laboratory Inc., El Dorado Hills, California. A follow-up dioxin/furan analysis is to be conducted by Twin Cities Testing Labs, Minneapolis, Minnesota.

Results

Physical

6. Table 1 shows the results of pertinent physical analyses. The whole of the physical results are in the attached Appendix. The median grain size was that of medium silt. The samples were clayey, sandy silt. They were 12 % clay, 14.5 % sand, and 73.5 % silt. They averaged 3.12 % total organic carbon (TOC) and 9.2 % volatile solids. The mean resuspended density was 1289 gm/L and the void ratio averaged 4.303. The particles roundness grading was subangular-subrounded. The average specific gravity was 2.669.

Chemical

Metals

7. The 1994 sediment samples were free of heavy metals contamination (Table 2) compared to the 1989 core samples which showed elevated levels of lead (Pb), mercury (Hg), and zinc (Zn). This suggests that the elevated metals are confined to the outer Dock A area or perhaps are located in older deeper sediment layers. Duplicates of one of the 1989 cores (M-2 REP 1 & 2) revealed variability in metals concentrations that can best be explained as due to 'patchiness' of metals in the sample. Whatever the case, no heavy metal concentration exceeded established levels of concern in the 1994 surface samples.

AVS

8. Acid volatile sulfides results were typical of boat basin environments (Table 2). AVS can be important when sediment is high in heavy metals. AVS serves as a reactive pool to form insoluble metal sulfides that are less toxic to aquatic organisms. Since the 1994 Moorings surface sediment samples, for

the most part, were not high in metals the importance of AVS is reduced.

TOC

9. Total organic carbon (TOC) concentrations were also typical of fine-grained sediments (Table 1). Because of their lipophilicity and hydrophobic nature, organic contaminants in water tend to partition into the carbon fraction in sediment. This removes contaminants from the water column. A high TOC content also decreases the theoretical bioaccumulation potential of contaminants in organisms exposed to sediment. The TOC content of Moorings sediment is on the high end of the scale compared to other projects in the Portland District. This is probably the result of inputs of carbon from living and decayed organic matter (as well as from contaminants such as PAHs).

Pesticides/PCBs

10. The 1989 cores contained concentrations of dieldrin, DDD, and DDT that exceeded concern levels (Table 3). No other pesticide was detected. No pesticides were detected in the 1994 surface samples except for DDD, DDE, and DDT. Concentrations of DDD in the 1989 core samples were an order-of-magnitude above the 1994 surface samples which ranged from 20 to 40 ppb. DDE was not detected in 1989 above the detection limit of 6.0 ppb while in 1994 concentrations between 4.0 and 6.0 ppb were reported to be present in all samples. DDT concentrations were more variable between stations in both 1989 and 1994. In 1989 DDT concentrations were reported as 40.0, 35.0, and 200.0 ppb. In 1994 concentrations varied from 6.0 to 200.0 (M-P-6) ppb. With the exception of M-P-6 all values for DDT were below 70.0 ppb. It is not unusual to find DDT and its metabolites in fine-grained sediment as they have been observed in sediments from throughout the country. This suggests that DDT and its metabolites are still present in sediment even though DDT has been banned since the early 1970's. DDT and its metabolites have consistently been found in sediments along the west bank of the Willamette River upstream of the Moorings. No PCBs were detected in any core or surface sample.

Phenols

11. Phenols were undetected in the samples (Table 4). Detection limits were high due to matrix interferences and sample dilution. Detection limits varied between 100 and 250 ppb. There is no reason-to-believe that a nearby source exists for phenols. This, combined with the fact that phenols are very soluble in water, makes it likely that phenols in the sediment are below concern levels.

Phthalates

12. The only phthalate detected was Bis(2-ethylhexyl)Phthalate and it ranged from 280 to 520 ppb. The highest concentration is far below the established concern level of 3,100 ppb. Bis(2-ethylhexyl)Phthalate is a component of plastics and is commonly found in boat basin sediment samples.

PAHs

13. Polynuclear aromatic hydrocarbons (PAHs) are contaminants associated with fuel and internal combustion engine by-products. PAHs were detected in

all samples collected at the Moorings (Table 5). Total PAHs ranged from 98,850 to 150,460 ppb in the core samples taken in 1989 on the river side of Dock A. In contrast the surface samples taken in 1994 were lower and ranged from 8,374 to 60,230 ppb. Surface samples close to Dock A were the highest in PAHs and samples further away were generally less contaminated. This suggests that the Dock A area might be more problematic than the rest of the Moorings in terms of PAH contamination. The highest concentration of surface samples (60,230 ppb total PAHs) was about two-thirds the lowest concentration of core samples (98,850 ppb total PAHs). This may indicate that deeper layers of sediment are more contaminated with PAHs, or, that recently deposited sediment is less contaminated with PAHs.

14. PAH concentrations exceeded established concern levels for both total and individual PAHs. All of the samples exceeded concern levels for total PAHs as well as established concern levels for total low molecular weight and high molecular weight PAHs. All sixteen PAHs were measured in amounts that exceeded concern levels in at least one sample analysis. Unquestionably, sediment at the Moorings is contaminated with PAHs.

TBT

15. Tributyltin (TBT) exceeded the EPA, Region 10 established concern level (30 ppb) in all 15 analyses (Table 6). Levels ranged from 52 to 410 ppb. The 30 ppb concern level is a screening level that is set conservatively low. Toxicity effects in bioassays typically occur at levels about 10 times higher - around 300 ppb. At the TBT levels found, bioassays would be required if this material is to be dredged and disposed in-water.

Dioxins/Furans

16. Dioxins and furans were detected in low concentrations (Table 7). The cores from 1989 were composited into one sample for dioxin/furans analysis (3). Four surface samples were analyzed in 1994. The results were fairly consistent between the cores and surface samples. The major difference of concern between the core samples and surface samples was that the most toxic dioxin congener, 2378-TCDD, was detected in the surface samples of 1994 but not the composited core sample of 1989. The concentration ranged from 0.82 to 2.0 parts per trillion (ppt). There is no current screening level for 2378-TCDD in sediment. Thus, the significance of these concentrations, that are so near the detection limit (0.22 ppt), are not easy to evaluate. Because the 2378-TCDD congener was detected in the 1994 samples and because of great public concern regarding the hazards of this congener, these samples are currently being analyzed again by another analytical company as a quality control/assurance measure. Results are not yet available. The other dioxin and furan congeners are in the range of concentrations that have been found at other sites in the Columbia River and along the Oregon Coast in river sediments (5,6,7).

Conclusions

17. Sediment from the U. S. Moorings is clayey, sandy silt high in organic content. PAHs are the major contaminants of concern with individual compounds and total amounts of PAHs detected far above established levels of concern. PAH contamination was evident in all analyses conducted. Other contaminants

of concern are TBT and DDT and its derivatives. Metals, PCBs, and pesticides, other than DDT and its derivatives, did not exceed concern levels in the 1994 surface samples. The contamination by the metals lead (Pb), mercury (Hg), and Zinc (Zn) and the pesticide Dieldrin found in the 1989 core samples was not evident in the 1994 surface samples.

REFERENCES

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7. Siipola M. U. S. Army Corps of Engineers, Portland District. 1991. Data collected on the Columbia River above Bonneville Dam as part of the draw down study and entered in Portland District database.

FIGURES

Willamette River

EB 8
FLOOD

M-3

TIDE GAGE

M-2

M-1

DOCK "A"

(23)

(19)

DOCK "B"

STAIRWAY

LOCK HOUSE

MICRO-WAVE TOWER

(P)

(20)

(9) DOCK OFFICE

(8) OFFICE

(8) LUNCH ROOM

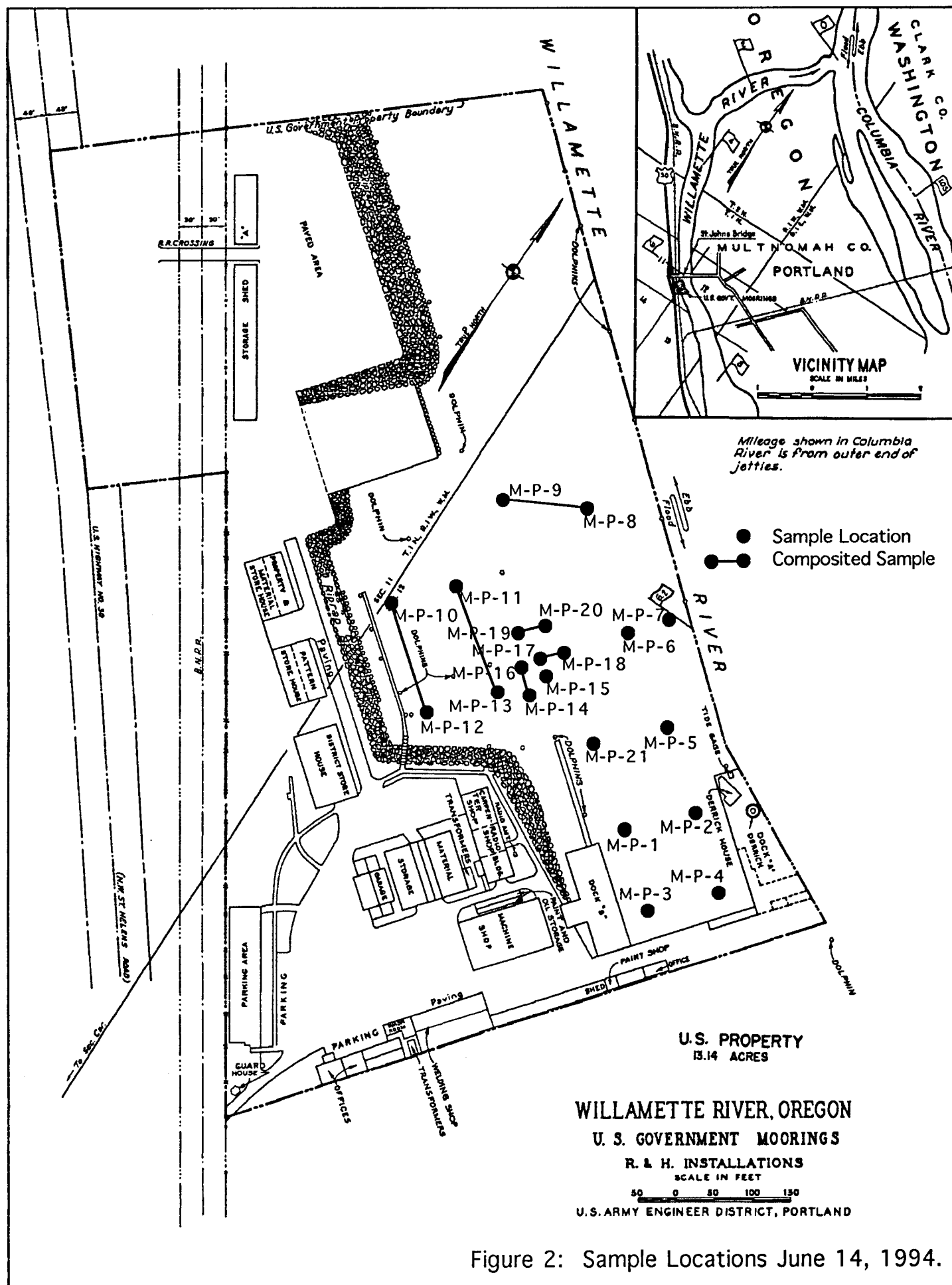
(8) RIGGING STORAGE ROOM

(8) ELECTRICAL EQUIPMENT ROOM

(8) STORAGE ROOM

(8) PAINT SHOP

Figure 1: Moorings Dock A Sample Locations 1989.



TABLES

Table 1: Sediment Physical Data

Location	Station	Date	Mean	Median	Sand	Silt	Clay	Volital Solids
			mm			% finer		
Moorings	M-1	10/12/89	0.054	0.030	78.0	62.9	14.3	11.0
Moorings	M-2	10/12/89	0.044	0.024	94.4	71.0	13.3	8.6
Moorings	M-3	10/12/89	0.036	0.021	94.7	76.8	16.1	8.1
Moorings	M-P-1	6/14/94	0.096	0.024	25.8	60.5	13.7	6.8
Moorings	M-P-2	6/14/94	0.024	0.018	9.7	77.5	12.8	9.5
Moorings	M-P-3	6/14/94	0.044	0.023	23.8	65.9	11.3	9.6
Moorings	M-P-4	6/14/94	0.028	0.019	14.4	73.1	12.5	9.7
Moorings	M-P-5	6/14/94	0.024	0.022	11.4	75.2	13.4	9.2
Moorings	M-P-6	6/14/94	0.025	0.020	11.6	75.6	12.8	10.1
Moorings	M-P-7	6/14/94	0.030	0.021	14.9	73.1	12.0	9.7
Moorings	M-P-8	6/14/94	0.032	0.025	16.2	71.6	12.2	9.2
Moorings	M-P-9	6/14/94	0.031	0.025	14.3	74.8	10.9	9.2
Moorings	M-P-10	6/14/94	0.082	0.062	49.3	45.5	5.2	7.9
Moorings	M-P-11	6/14/94	0.028	0.024	10.8	80.1	9.1	9.7
Moorings	M-P-12	6/14/94	0.033	0.026	15.5	73.1	11.4	9.3
Moorings	M-P-13	6/14/94	0.027	0.020	12.2	74.3	13.5	8.2
Moorings	M-P-14	6/14/94	0.027	0.022	11.3	77.5	11.2	8.9
Moorings	M-P-15	6/14/94	0.027	0.021	11.6	76.5	11.9	9.3
Moorings	M-P-16	6/14/94	0.024	0.018	9.1	77.5	13.4	8.5
Moorings	M-P-17	6/14/94	0.025	0.016	10.9	79.2	9.9	9.7
Moorings	M-P-18	6/14/94	0.020	0.016	7.7	76.5	15.8	8.9
Moorings	M-P-19	6/14/94	0.022	0.018	6.6	80.7	12.7	10.1
Moorings	M-P-20	6/14/94	0.073	0.018	7.9	78.1	14.0	9.5
Moorings	M-P-21	6/14/94	0.023	0.018	9.2	77.9	12.9	10.2

Table 2: Sediment Heavey Metals Data

Location	Station	Date	Arsenic	Chromium	Lead	Mercury	Nickel	Zinc	Cadmium	AVS
Moorings	M-1	10/12/89	3.7	29.0	335.0	0.148	29.0	183.0	0.44	
Moorings	M-2 REP 1	10/12/89	4.7	32.0	175.0	0.224	37.0	158.0	0.39	
Moorings	M-2 REP 2	10/12/89	4.4	37.0	331.0	0.321	39.0	77.0	0.43	
Moorings	M-3	10/12/89	5.3	34.0	50.0	0.429	39.0	77.0	0.43	
Moorings	M-P-1	6/14/94	3.5	29.4	45.0	0.100	23.7	135.0	0.35	250
Moorings	M-P-2	6/14/94	3.7	28.4	33.1	0.100	22.9	109.0	0.32	110
Moorings	M-P-3	6/14/94	6.7	44.2	86.9	0.130	29.0	175.0	0.43	1100
Moorings	M-P-4	6/14/94	3.9	27.0	27.5	0.100	20.6	107.0	0.30	73
Moorings	M-P-5	6/14/94	3.6	29.6	34.3	0.110	21.7	115.0	0.32	40
Moorings	M-P-6	6/14/94	3.3	27.0	27.5	0.100	20.6	107.0	0.30	30
Moorings	M-P-7	6/14/94	3.5	27.7	25.5	0.110	21.5	116.0	0.31	48
Moorings	M-P-8/9	6/14/94	3.1	26.1	28.2	0.090	22.2	110.0	0.34	41
Moorings	M-P-10/12	6/14/94	5.3	56.4	42.0	0.110	33.0	147.0	0.55	31
Moorings	M-P-11/13	6/14/94	2.7	27.8	32.2	0.100	20.2	116.0	0.30	20
Moorings	M-P-14/16	6/14/94	3.5	27.0	29.2	0.100	20.2	116.0	0.30	100
Moorings	M-P-15	6/14/94	4.1	27.8	32.2	0.100	20.2	116.0	0.30	46
Moorings	M-P-17/18	6/14/94	3.4	30.2	27.0	0.100	23.1	110.0	0.32	41
Moorings	M-P-19/20	6/14/94	3.3	28.4	23.7	0.090	21.5	99.6	0.27	36
Moorings	M-P-21	6/14/94	3.6	28.7	31.8	0.100	21.9	112.0	0.33	54

Table 3: Sediment Pesticide Data

Location	Station	Date	Aldrin	Chlordane	Dieldrin	DDD	DDE	DDT	Endosulfan	Endrin	Hepachlor	Lindane	Metoxychlor	Toxaphene
Moorings	M-1	10/12/89	-3	-5	11	130	-6	40	-6	-6	-3	-3	-12	-450
Moorings	M-2 REP 1	10/12/89	-3	-5	11	110	-6	35	-6	-6	-3	-3	-12	
Moorings	M-3	10/12/89	-3	-5	29	470	-6	200	-6	-6	-3	-3	-12	-450
Moorings	M-P-1	6/14/94	-4	-50	-2	30	6	6	0	-3	-2	-2	-30	-100
Moorings	M-P-2	6/14/94	-4	-70	-2	30	5	20	-2	-2	-2	-5	-40	-200
Moorings	M-P-3	6/14/94	-5	-60	-2	40	5	10	-2	-2	-2	-20	-50	-200
Moorings	M-P-4	6/14/94	-4	-70	-4	30	4	40	-4	-5	-2	-7	-50	-200
Moorings	M-P-5	6/14/94	-4	-70	-2	30	4	70	-2	-2	-2	-3	-20	-200
Moorings	M-P-6	6/14/94	-2	-60	-2	30	5	200	-7	-2	-2	-2	-20	-200
Moorings	M-P-7	6/14/94	-2	-70	-2	30	4	50	-2	-2	-2	-2	-6	-200
Moorings	M-P-8/9	6/14/94	-2	-60	-2	30	5	30	-2	-2	-2	-2	-8	-200
Moorings	M-P-10/12	6/14/94	-7	-60	-2	20	4	7	-2	-2	-2	-2	-20	-100
Moorings	M-P-11/13	6/14/94	-4	-60	-2	20	4	30	-2	-2	-2	-2	-10	-100
Moorings	M-P-14/16	6/14/94	-5	-70	-2	20	5	40	-2	-2	-2	-2	-9	-200
Moorings	M-P-15	6/14/94	-2	-60	-2	20	4	4	-4	-2	-2	-4	-30	-200
Moorings	M-P-17/18	6/14/94	-5	-70	-2	20	5	30	30	-2	-2	-4	-20	-200
Moorings	M-P-19/20	6/14/94	-4	-70	-2	20	5	5	-6	-2	-2	-2	-20	-200
Moorings	M-P-21	6/14/94	-5	-70	-2	20	6	17	-6	-2	-2	-2	-20	-200

Location	Station	Date	Alpha-BHC	Beta-BHC	Beta Epoxide	Heptachlor Epoxide	Endosulfan I	Endosulfan II	Endrin Aldehyde	Endosulfan Sulfate
Moorings	M-1	10/12/89								
Moorings	M-2 REP 1	10/12/89								
Moorings	M-3	10/12/89								
Moorings	M-P-1	6/14/94	-2	-5	-2	-2	-2	-4	-3	-4
Moorings	M-P-2	6/14/94	-2	-5	-2	-2	-2	-3	-2	-2
Moorings	M-P-3	6/14/94	-2	-5	-2	-2	-2	-5	-2	-2
Moorings	M-P-4	6/14/94	-2	-5	-2	-2	-2	-2	-5	-4
Moorings	M-P-5	6/14/94	-2	-5	-2	-2	-2	-2	-2	-2
Moorings	M-P-6	6/14/94	-2	-5	-2	-2	-2	-2	-2	-7
Moorings	M-P-7	6/14/94	-2	-5	-2	-2	-2	-2	-2	-2
Moorings	M-P-8/9	6/14/94	-2	-5	-2	-2	-2	-2	-2	-2
Moorings	M-P-10/12	6/14/94	-2	-5	-2	-2	-2	-2	-2	-2
Moorings	M-P-11/13	6/14/94	-2	-5	-2	-2	-2	-2	-2	-2
Moorings	M-P-14/16	6/14/94	-2	-5	-2	-2	-2	-2	-2	-2
Moorings	M-P-15	6/14/94	-2	-5	-2	-2	-2	-4	-2	-4
Moorings	M-P-17/18	6/14/94	-2	-5	-2	-2	-2	-2	-2	-2
Moorings	M-P-19/20	6/14/94	-2	-5	-2	-2	-2	-2	-2	-6
Moorings	M-P-21	6/14/94	-2	-5	-2	-2	-2	-2	-2	-6

Table 4 Sediment Phthalates/Phenols

Location	Station	Date	Dimethyl Phthalate	Diethyl- phthalate	Di-n-Butyl- phthalate	Butylbenzyl- phthalate	bis(2-Ethylhexyl) Phthalate	Di-n-Octyl Phthalate	Phenol	2-Methyl- phenol	3,4-Methyl- phenol	2,4-Dimethyl- phenol	Pentachloro- phenol
Moorings	M-1	10/12/89	-100	-100	-100	-100	87	-100	-210	-100	-100	-210	-520
Moorings	M-2	10/12/89	-500	-500	-500	-500	-500	-500	-990	-500	-500	-990	-2500
Moorings	M-3	10/12/89	-430	-430	-430	-430	-430	-430	-860	-430	-430	-860	-2200
Moorings	M-P-1	6/14/94	-50	-50	-50	-50	520	-50	-100	-100	-100	-100	-250
Moorings	M-P-2	6/14/94	-50	-50	-50	-50	360	-50	-100	-100	-100	-100	-250
Moorings	M-P-3	6/14/94	-50	-50	-50	-50	430	-50	-100	-100	-100	-100	-250
Moorings	M-P-4	6/14/94	-50	-50	-50	-50	400	-50	-100	-100	-100	-100	-250
Moorings	M-P-5	6/14/94	-50	-50	-50	-50	380	-50	-100	-100	-100	-100	-250
Moorings	M-P-6	6/14/94	-50	-50	-50	-50	350	-50	-100	-100	-100	-100	-250
Moorings	M-P-7	6/14/94	-50	-50	-50	-50	280	-50	-100	-100	-100	-100	-250
Moorings	M-P-8/9	6/14/94	-50	-50	-50	-50	340	-50	-100	-100	-100	-100	-250
Moorings	M-P-10/12	6/14/94	-50	-50	-50	-50	460	-50	-100	-100	-100	-100	-250
Moorings	M-P-11/13	6/14/94	-50	-50	-50	-50	310	-50	-100	-100	-100	-100	-250
Moorings	M-P-14/16	6/14/94	-50	-50	-50	-50	370	-50	-100	-100	-100	-100	-250
Moorings	M-P-15	6/14/94	-50	-50	-50	-50	340	-50	-100	-100	-100	-100	-250
Moorings	M-P-17/18	6/14/94	-50	-50	-50	-50	280	-50	-100	-100	-100	-100	-250
Moorings	M-P-19/20	6/14/94	-50	-50	-50	-50	340	-50	-100	-100	-100	-100	-250
Moorings	M-P-21	6/14/94	-50	-50	-50	-50	450	-50	-100	-100	-100	-100	-250

Table 5: Sediment Polyaromatic Hydrocarbons (PAHs)

Location	Station	Date	Acenaphthylene	Anthracene	Fluorene	Naphthalene	Phenanthrene	Total LPAHs
Moorings	M-1	10/12/89	470	5,500	5,300	21,000	29,000	70,200
Moorings	M-2	10/12/89	-500	5,400	4,600	550	23,000	42,050
Moorings	M-3	10/12/89	300	5,400	3,900	840	21,000	35,940
Moorings	M-P-1	6/14/94	170	810	600	170	4,200	6,779
Moorings	M-P-2	6/14/94	170	860	470	180	4,400	6,900
Moorings	M-P-3	6/14/94	350	1,200	640	320	5,100	8,500
Moorings	M-P-4	6/14/94	190	890	300	280	2,800	4,970
Moorings	M-P-5	6/14/94	120	560	310	150	2,300	4,040
Moorings	M-P-6	6/14/94	96	420	180	130	1,500	2,678
Moorings	M-P-7	6/14/94	77	400	120	92	1,200	2,089
Moorings	M-P-8/9	6/14/94	88	320	140	110	1,200	2,148
Moorings	M-P-10/12	6/14/94	53	420	220	99	1,700	2,988
Moorings	M-P-11/13	6/14/94	-50	210	110	65	890	1,455
Moorings	M-P-14/16	6/14/94	72	260	150	91	980	1,753
Moorings	M-P-15	6/14/94	99	920	1,300	120	6,500	10,469
Moorings	M-P-17/18	6/14/94	55	500	150	100	1,000	2,035
Moorings	M-P-19/20	6/14/94	-50	160	92	61	640	1,073
Moorings	M-P-21	6/14/94	120	420	210	150	1,700	2,970

Location	Station	Date	Benzo(a) Anthracene	Benzo(bk) Fluoranthene	Benzo(ghi) Perylene	Benzo(a) Pyrene	Chrysene	Dibenzo(ah) Anthracene	Indeno(123-cd) Pyrene	Fluoranthene	Pyrene	Total HPAHs	Dibenzofuran
Moorings	M-1	10/12/89	4,700	6,800	5,700	5,500	5,900	760	3,900	20,000	27,000	80,260	770
Moorings	M-2	10/12/89	3,600	4,900	3,000	4,100	4,800	-500	2,400	13,000	19,000	54,800	750
Moorings	M-3	10/12/89	4,400	5,700	4,900	4,600	5,300	830	3,200	12,000	20,000	60,930	560
Moorings	M-P-1	6/14/94	2,500	4,500	1,500	2,500	3,100	330	2,300	6,000	6,400	29,130	-50
Moorings	M-P-2	6/14/94	2,000	3,500	1,400	2,300	2,300	340	2,100	5,100	5,600	22,340	-50
Moorings	M-P-3	6/14/94	4,200	7,600	3,000	4,600	4,700	730	4,900	11,000	11,000	51,730	180
Moorings	M-P-4	6/14/94	2,400	4,600	1,800	3,000	2,800	470	2,800	5,800	6,000	26,400	86
Moorings	M-P-5	6/14/94	1,800	3,300	1,100	2,100	2,100	330	1,900	4,500	4,500	21,630	120
Moorings	M-P-6	6/14/94	1,400	2,600	930	1,900	1,600	234	1,600	3,000	3,200	16,464	67
Moorings	M-P-7	6/14/94	1,100	2,200	1,100	1,600	1,200	300	1,700	2,400	2,700	14,300	-50
Moorings	M-P-8/9	6/14/94	1,300	2,400	790	1,700	1,400	240	1,500	2,400	2,600	14,330	51
Moorings	M-P-10/12	6/14/94	2,200	4,300	1,100	2,700	2,100	500	2,300	3,500	3,400	22,100	110
Moorings	M-P-11/13	6/14/94	910	1,800	510	1,200	1,000	180	1,000	1,800	1,700	10,100	-50
Moorings	M-P-14/16	6/14/94	1,000	1,900	600	1,300	1,200	190	1,100	2,100	2,100	11,490	72
Moorings	M-P-15	6/14/94	3,300	4,400	760	2,200	3,500	230	1,500	12,000	9,200	37,090	-50
Moorings	M-P-17/18	6/14/94	960	1,800	510	1,200	1,100	90	9,900	2,200	2,400	20,160	60
Moorings	M-P-19/20	6/14/94	630	1,200	370	780	730	61	630	1,400	1,500	7,301	-50
Moorings	M-P-21	6/14/94	1,300	2,600	1,000	1,800	1,500	190	2,200	3,500	1,000	15,090	76

Table 6: Sediment TBT and PCB Data

Location	Station	Date	Butyltin	Dibutyltin	tributyltin	Alclor 1242	Alclor 1248	Alclor 1254	Alclor 1260
						-60	-60	-60	-60
Moorings	M-1	10/12/89				-60	-60	-60	-60
Moorings	M-2	10/12/89				-60	-60	-60	-60
Moorings	M-3	10/12/89				-60	-60	-60	-60
Moorings	M-P-1	6/14/94	26	43	110	-70	-70	-70	-70
Moorings	M-P-2	6/14/94	7	11	52	-80	-80	-80	-80
Moorings	M-P-3	6/14/94	39	120	410	-80	-80	-80	-80
Moorings	M-P-4	6/14/94	15	40	150	-40	-40	-90	-90
Moorings	M-P-5	6/14/94	10	26	93	-40	-40	-80	-80
Moorings	M-P-6	6/14/94	11	36	130	-40	-40	-80	-80
Moorings	M-P-7	6/14/94	21	60	200	-40	-40	-80	-40
Moorings	M-P-8/9	6/14/94	22	80	240	-40	-40	-80	-40
Moorings	M-P-10/12	6/14/94	22	55	160	-40	-40	-70	-70
Moorings	M-P-11/13	6/14/94	12	40	85	-40	-40	-70	-40
Moorings	M-P-14/16	6/14/94	13	47	150	-40	-40	-80	-40
Moorings	M-P-15	6/14/94	12	28	110	-40	-40	-80	-40
Moorings	M-P-17/18	6/14/94	12	30	87	-40	-40	-80	-40
Moorings	M-P-19/20	6/14/94	6	25	90	-40	-40	-40	-40
Moorings	M-P-21	6/14/94	11	24	94	-40	-40	-40	-40

TABLE 7: SEDIMENT DIOXIN/FURAN DATA

Location	Station	Date	2,3,7,8- TCDD	Total TCDD	1,2,3,7,8- PECDD	Total PECDD	1,2,3,4,7,8- HxCDD	1,2,3,6,7,8- HxCDD	1,2,3,7,8,9, HxCDD	Total HxCDD	1,2,3,4,6,7,8- HPCDD	Total HPCDD	OCDD
Moorings	M-1,2,3 COMP	10/12/89	-0.71	11.0	-1.5	-1.5	-2.8	-14.0	-13.0	120	320	740	3400
Moorings	M-P-4	6/14/94	1.50	2.5	3.0	6.4	5.2	21.0	10.0	130	360	820	2500
Moorings	M-P-5	6/14/94	2.00	5.0	1.7	4.7	3.2	14.0	6.1	92	260	660	2300
Moorings	M-P-6	6/14/94	1.40	4.4	1.3	3.6	2.2	8.4	4.7	62	170	400	1500
Moorings	M-P-15	6/14/94	0.82	5.3	2.1	7.5	3.5	16.0	6.8	120	400	1900	7500

Location	Station	Date	2,3,7,8- TCDF	Total TCDF	1,2,3,7,8- PECDF	2,3,4,7,8- PECDF	Total PECDF	1,2,3,4,7,8- HxCDF	1,2,3,6,7,8- HxCDF	2,3,4,6,7,8- HxCDF	1,2,3,7,8,9- HxCDF	Total HxCDF	1,2,3,4,6,7,8- HPCDF	1,2,3,4,7,8,9- HPCDF	Total HPCDF	OCDF
Moorings	M-1,2,3 COMP	10/12/89	26.0	57.0	22.0	17.0	98.0	33.0	11.0	-1.9	5.8	130	140	7.8	440	570
Moorings	M-P-4	6/14/94	17.0	64.0	23.0	15.0	97.0	36.0	12.0	6.7	5.8	150	58	9.0	170	130
Moorings	M-P-5	6/14/94	15.0	68.0	17.0	12.0	76.0	34.0	10.0	5.0	5.5	130	58	8.7	160	130
Moorings	M-P-6	6/14/94	10.0	44.0	13.0	9.1	53.0	20.0	6.4	3.6	3.3	73	33	5.6	93	87
Moorings	M-P-15	6/14/94	16.0	65.0	33.0	19.0	110.0	45.0	15.0	6.8	7.3	180	90	9.8	280	280

**Physical and
Chemical Raw Data
Not Included
Because of Size**

(Contact Mark Siipola at 503-808-4885)